DECEMBER 2020

PROTEIN

Essential amino acids and protein quality

Recommendations for different target groups

Health benefits of protein

PROTEIN

Proteins play an important role in supporting health throughout all stages of life: from growing up to healthy ageing. For children, proteins are essential for normal growth and development.[1] Later in life proteins help to maintain muscle mass and muscle strength, which is essential for staying mobile and active.[2] Adequate muscle mass also contributes to the resilience needed to be able to cope with critical situations such as hospitalization, courses of treatment or recovery.[2]

PROTEIN
levels in food

FUNCTIONS OF PROTEIN

Proteins support many different functions in the body. Firstly, proteins are an important structural component of cells and tissues and are present in muscles, organs, bones, blood, skin and the nervous system. Proteins are needed to repair or replace damaged tissue, for example muscles. Next to that, some proteins act as enzymes or certain hormones. Proteins also play a role in the immune system, in the transport of nutrients and in the transmission of signals within cells. Finally, when no other energy source is available, proteins can be used by the body for energy.[1]

All plant and animal derived foods contain protein. Foods with a high content of animal protein are meat, fish, eggs, milk and other dairy products.[3] Foods with a high content of plant protein are bread and other cereal products, legumes and nuts.[3]

Animal-derived foods	Protein content (g/100 gram)	Serve size (g)	Protein content per serve (g)
Poultry	22 - 37	100	22 - 37
Cheese, hard	27 - 34	20	5.4 – 6.8
Red meat	20 - 33	100	20 – 33
Cheese, soft	12 - 28	20	2.4 – 5.6
Fish	15 - 25	100	15 - 25
Eggs	11 - 13	50	5.5 – 6.5
Milk products	2 - 6	150	3 - 9

Plant-derived foods	Protein content (g/100 gram)	Serve size (g)	Protein content per serve (g)
Nuts and seeds	8 - 29	25	2 – 7.3
Legumes	4 - 14	135	5.4 – 18.9
Bread and rolls	6 - 13	35	2.1 – 4.6
Breakfast cereals	5 - 13	50	2.5 – 6.5
Pasta and rice (cooked)	2 - 6	50	1 - 3
Vegetables	1 - 5	50	0.5 – 2.5
Fruits	0.3 - 2	100	0.3 – 2

PROTEIN CONTENT
of some animal and plant-derived foods[3]

AMINO ACIDS

What are proteins? Proteins are built from smaller building blocks called amino acids and most proteins consist of a sequence of approximately 300 amino acids.[4] There are 20 different amino acids which can be classified into non-essential, semi-essential and essential amino acids.[4,5] Non-essential amino acids can be produced by the body when the intake of these amino acids from the diet is insufficient. Essential amino acids, of which there are 9, cannot be produced by the body and therefore need to be obtained via the diet.[3,5] There are also 6 semi-essential amino acids.[3] Under certain circumstances, the body cannot produce these amino acids in sufficient quantities. In those situations, semi-essential amino acids need to be supplemented via the diet.[3]

Functions of the 9 ESSENTIAL AMINO ACIDS[6]

1. Lysine

Involved in protein synthesis, hormone and enzyme production and absorption of calcium. Important for energy production, immune function and production of collagen and elastin.

2. Histidine

Necessary to produce histamine for immune response and sleep-wake cycles. Critical for building and maintaining the myelin sheath, a protective barrier surrounding the axons of nerve cells.

3. Isoleucine

Involved in healing/repair of muscle tissue. Important for immune function, hemoglobin production and energy regulation.

4. Leucine

Important for protein synthesis and muscle repair. Helps regulate blood sugar levels, stimulates wound healing and produces growth hormones.

5. Valine

Helps stimulate muscle growth and regeneration and involved in energy production.

6. Methionine

Important role in metabolism and detoxification. Necessary for tissue growth and absorption of zinc and selenium.

7. Phenylalanine

Precursor for neurotransmitters tyrosine, dopamine, epinephrine and norepinephrine. Integral role in structure and function of proteins and enzymes and production of other amino acids.

8. Threonine

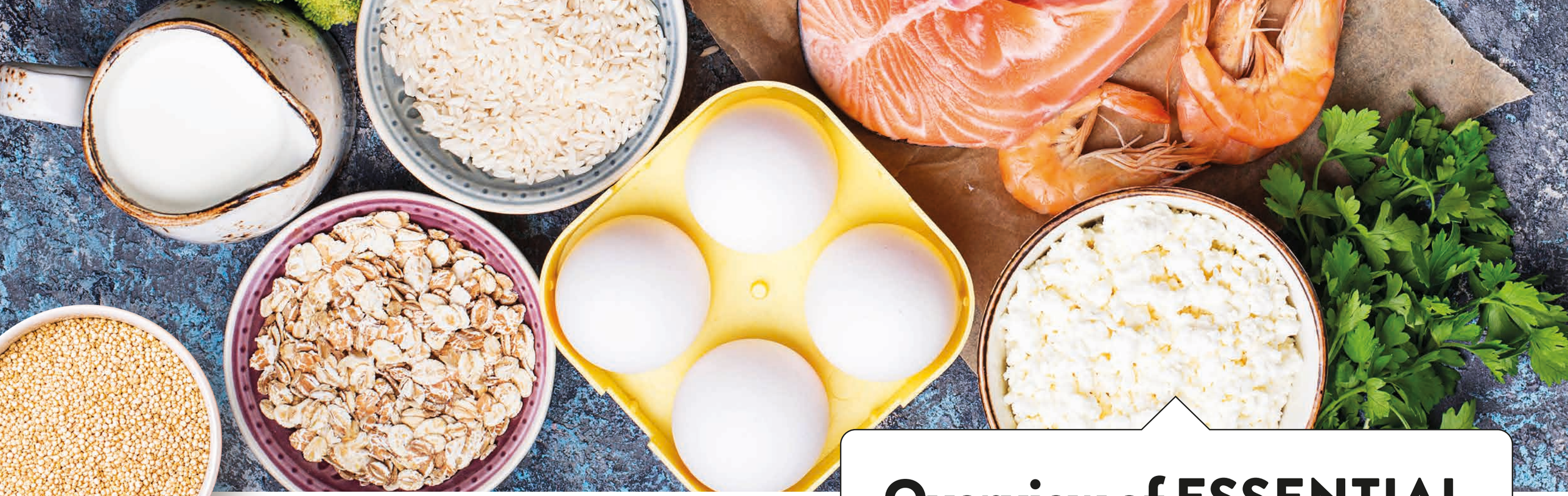
Major part of collagen and elastin, which are important components of skin and connective tissue. Plays a role in fat metabolism and immune function.

9. Tryptophan

Maintain nitrogen balance, precursor to serotonin, a neurotransmitter that regulates appetite, sleep and mood.

THE 6 SEMI-ESSENTIAL AMINO ACIDS[1]

1. Arginine
2. Cysteine
3. Glutamine
4. Glycine
5. Proline
6. Tyrosine



PROTEIN QUALITY

Some proteins are of a higher quality than other proteins as they contain all the essential amino acids in favorable amounts.[3,5] This means that the essential amino acids needed for maintenance of the body, e.g. the renewing of tissues such as muscles and bones, are all present in sufficient quantities.[7] High-quality proteins are also highly digestible[3], meaning that the protein is accessible for digestive enzymes in the gastrointestinal tract and all the amino acids, including the essential ones, can be absorbed.

In general, proteins of animal origin are of higher quality compared with plant proteins. Animal proteins usually contain all essential amino acids in favorable amounts and are well digested.[3,5] Plant proteins usually contain fewer essential amino acids or in a less favorable ratio, and are more difficult to digest.[3] The latter is mainly due to the presence of anti-nutritive factors such as plant cell walls and enzyme inhibiters, which limits protein digestibility.[8] Thereby, the availability of (essential) amino acids is lowered, meaning less (essential) amino acids can be absorbed by the body.

Overview of ESSENTIAL AMINO ACIDS

in mg per g protein of various protein sources[9]

Essential amino acid* (mg/g protein)	Reference diet** adult	Milk	Whey***	Casein***	Eggs	Beef	Soy	Grains	Rice
Lysine	48	83	107	82	72	89	60	23	34
Histidine	16	28	22	29	23	44	25	21	21
Isoleucine	30	64	57	62	69	50	42	34	40
Valine	40	68	53	73	74	53	47	38	54
Methionin, including cysteine	23	32	52	33	51	36	24	36	42
Phenylalanine, including tyrosine	41	105	76	116	104	91	88	77	94
Threonine	25	51	54	45	50	47	40	28	34
Tryptophan	7	14	21	12	16	14	12	10	11
Total of essential amino acids	**291**	**538**	**571**	**549**	**541**	**503**	**423**	**336**	**407**

Source: FAO/WHO/UNU Expert Consultation, 2007

* Both the sulphurous (methionine and cysteine) and the aromatic (phenylalanine and tyrosine) essential amino acids are strongly interlinked in the metabolism and so they are often totalled to compare proteins. Therefore sometimes 9 to 11 essential amino acids are mentioned.

** The reference pattern should provide adults with the necessary essential amino acids. Source: FAO, 2011

*** Source: Walstra P et al. 2006; Hiprotal Casein Whey 80 (DOMO, FrieslandCampina)

Methods to measure PROTEIN QUALITY

There are different methods for measuring protein quality. Two widely known and used methods are the Protein-Digestibility-Corrected Amino Acid Score (PDCAAS) and the Digestible Indispensable Amino Acid Score (DIAAS). Both methods take into account the amount of essential amino acids and protein digestibility. The difference is that the DIAAS score takes the digestibility of each individual essential amino acid into account, instead of the digestibility of the entire protein. Therefore, the FAO recommends the use of the DIAAS score.[7,8] Figure 1 shows the PDCAAS and DIAAS scores for different proteins.

HIGH QUALITY PROTEIN IS CRITICAL TO DELIVER ESSENTIAL AMINO ACIDS IN AN EFFECTIVE WAY TO THE BODY

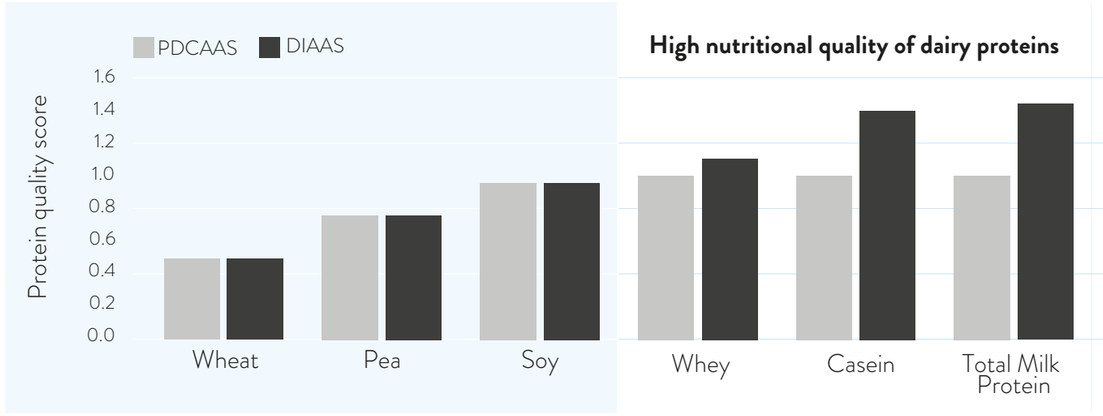


Figure 1. Protein quality score of different proteins as expressed in Digestible Indispensable Amino Acid Score (DIAAS) and Protein Digestibility Corrected Amino Acid Score (PDCAAS) for a variety of proteins.[7-9,12-15]

SUSTAINABILITY ASPECTS

Diets that primarily contain animal derived foods are associated with higher greenhouse gas emissions compared with diets that contain more plant derived foods. Accordingly, to reduce the environmental impact of diets, it is often recommended to consume more plant based protein. However, it is also important to consider the different protein needs at various stages of life. Due to their low food intake and increased protein needs, many older adults and those suffering from illness or recovering from illness could benefit from additional protein. Compared with plant based protein sources, at low- to moderate intake levels, muscle protein synthesis in older adults seems to be stimulated to a greater extent by animal based protein sources, such as dairy.[10,11] With advancing age, the maintenance of muscle mass becomes increasingly important. Therefore, the recommendation to consume more plant based proteins should be balanced against protein recommendations for improving the health of (frail) older adults.

MILK PROTEINS

Milk and dairy products are nutrient dense foods and supply significant amounts of protein.[16] As shown in Figure 1, the quality of milk proteins is high, scoring ≥ 1.0.

WHEY AND CASEIN

The major proteins found in bovine milk are casein and whey, with casein accounting for approximately 80% of the protein in milk and whey for 20%.[16] Whey protein is considered to be a fast-digested protein, while casein is considered a slow-digested protein.[17] Whey proteins are therefore absorbed quickly and give an amino acid peak in the first two hours after consumption. Casein is digested more slowly and so the amino acids are released over a longer period of time.[17] For developing and maintaining muscle mass, whey protein supplements are often used in the period immediately after exercise as they are absorbed rapidly and stimulate muscle protein synthesis.[17] Consumption of casein just before going to sleep can help to maintain muscle mass by enhancing protein synthesis during the night.[18]

PROTEIN RECOMMENDATIONS for different age groups

CHILDREN

Growth occurs rapidly during infancy, childhood and adolescence. Calories and protein contribute to this rapid growth. Table 3 shows protein recommendations for children per age category. These recommendations were established during a joint expert consultation of the World Health Organization (WHO), the Food and Agricultural Organization of the United Nations (FAO) and United Nations University (UNU).9

Age (years)	Protein (g/kg body weight/day)
0.5	1.31
1	1.14
1.5	1.03
2	0.97
3	0.9
4 - 6	0.87
7 - 10	0.92
11-14	0.9 (boy), 0.89 (girl)
15-18	0.87 (boy), 0.84 (girl)

Table 3. Daily protein recommendations for children (WHO/FAO/UNU) [9]

Scan the QR code to see protein recommendations for children from national health authorities around the world.

INSUFFICIENT PROTEIN AND ENERGY INTAKE

When children consume inadequate protein and energy, this can result in a form of undernutrition called protein-energy malnutrition (PEM)[19], which occurs most often in early childhood.[1] It is most prevalent in Africa, Central America, South America and East and Southeast Asia.[1] PEM can result in wasting (low weight for height) or stunting (low height for age).[19] Additional protein intake might be beneficial for catch-up growth in children who are stunted and for rapid weight gain in wasted children.[19] Not only the quantity, but also the quality of the consumed protein matters: according to a study of Ghosh et al. the intake of high quality protein seems to be associated with less stunting.[20]

ADULTS

Health authorities usually recommend a protein intake of 0.8 g/kg body weight/day for healthy adults. This equates to 56 gram of protein per day for a person weighing 70 kg.

VEGETARIANS & VEGANS

Protein requirements for healthy adults have not been found to differ according to whether dietary protein is predominantly from animal, vegetable or mixed protein sources. Vegetarian and vegan diets typically meet or exceed recommended protein intakes when energy needs are met. In order to obtain a sufficient amount of all the essential amino acids, it is important to eat protein from a variety of sources, for example legumes, nuts and dairy.[21-22]

PREGNANCY & BREAST-FEEDING

During pregnancy and breastfeeding, protein requirements are higher. During the course of pregnancy, protein requirements rise with the highest amount of extra protein needed in the third trimester.[3,23] The European Food Safety Authority (EFSA) and the FAO recommend an additional protein intake of around 1 gram per day in the first trimester, 9 gram per day in the second trimester and around 30 gram per day in the third trimester.[3,9] During breastfeeding, an additional protein intake of ~ 19 gram per day during the first six month and of ~ 13 gram per day after six months is recommended.[3,9]

In some developing countries, protein intake during pregnancy and breastfeeding may be insufficient. For example, a recent review showed that the protein intake of adolescent girls, pregnant women and lactating women in Nigeria is inadequate.[19] Balanced energy and protein supplementation, which provides roughly 25% of the total energy supplement as protein, is an important intervention for the prevention of adverse perinatal outcomes in undernourished women.[24] It increases birth weight by 41 gram and reduces the risk of stillbirths by 40% and small-for-gestational-age births by 21%. WHO recommends nutrition education and increasing daily energy and protein intake for pregnant women in undernourished populations, to reduce the risk of low-birth-weight newborns.[24]

DID YOU KNOW?

SAFE UPPER LIMIT

Can too much protein be dangerous? Currently, there is no clear safe upper limit for protein intake.[3,7] Estimates however suggest a maximum safe protein intake of approximately 25% of energy requirements at approximately 2 to 2.5 g/kg body weight/day.[27]

BONES

Is protein beneficial to bones? In 2018, twelve experts in bone health published a consensus report summarizing the most recent insights on protein intake and bone health.[25]

CONCLUSIONS

- Bone mineral density, which is an important determinant of bone strength, appears to be positively associated with dietary protein intake.
- Although acid loading or a high protein diet is associated with increased urinary calcium excretion, higher protein intake, whatever the origin (animal or vegetable), does not appear to contribute to weaker bones.
- Protein intake above the current recommendation does not have an adverse effect on bone health, provided that calcium intake is adequate.

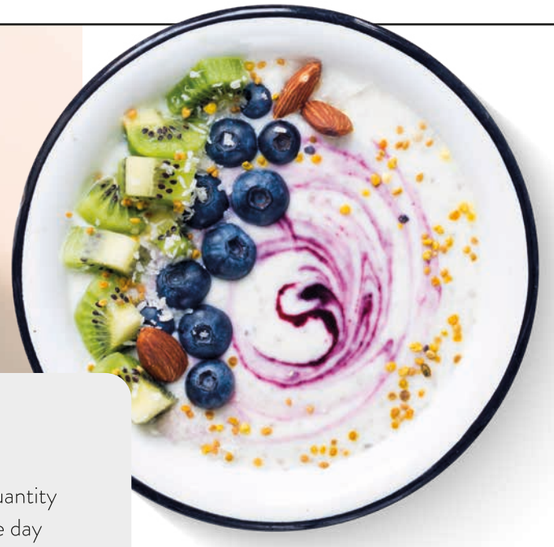
ATHLETES

Athletes generally have a larger muscle mass to maintain and may be training to increase their muscle mass. Intensive resistance exercise is also associated with muscle fiber damage and so athletes and sportspeople require more protein for muscle repair and regeneration than the general population. These additional protein requirements depend on multiple factors. Generally endurance athletes have a slight to moderate increased protein requirement, whereas the advice for strength athletes is twice that of the general population. The most recent advice from the Academy of Nutrition and Dietetics, Dieticians of Canada and the American College of Sports Medicine advises that protein requirements are dependent on training status (well-trained athletes need a somewhat smaller quantity than less well-trained athletes) and the intensity of the training (the higher the frequency and the intensity, the higher the requirement). This results in a protein recommendation between 1.2 and 2.0 g/kg body weight.[28]

Eating more protein than the recommended amounts is not helpful in terms of muscle development.[29] Unlike fats and carbohydrates, proteins are not stored in the body. When more protein is eaten than the capacity to synthesize muscle protein, the 'excess' protein is simply used an energy source. Also when energy intake is low, e.g. in sports in which weight plays an important role, protein is used as an energy source and therefore cannot be used for muscle protein synthesis.[28] When weight loss is the goal, while an athlete wants to maintain his or her muscle mass, a higher protein intake of 1.6 - 2.4 g/kg body weight/day may be beneficial.[30] In general, when the diet matches the athlete's energy requirements, it will usually also contain a sufficient amount of protein.

LEUCINE

For maintaining and building muscle mass, sufficient protein intake with a sufficient amount of essential amino acids is important for athletes. The essential amino acids leucine, together with training, is an important stimulus for muscle protein synthesis. Several studies in young athletes show that consuming 20 gram of protein with each meal, in combination with resistance training, is sufficient for stimulating muscle protein synthesis. This 20 gram of protein should be of high quality and contain a sufficient amount of leucine.[17,29,31,32]



PROTEIN DISTRIBUTION

Research has shown that apart from the total quantity of protein, distribution of protein intake over the day is also important for muscle protein synthesis. To optimize muscle protein synthesis it is recommended to divide the total daily protein requirement over four to six eating occasions in portions of 0.25-0.3 g protein/kg body weight. In practice this comes down to about 20 grams of protein per meal, for example at breakfast, lunch, dinner, post- exercise and just before going to sleep. This pattern of protein distribution over the day can enhance muscle growth compared to when the total protein requirement is consumed in two or three larger portions or over several smaller portions during the day.[33,34]

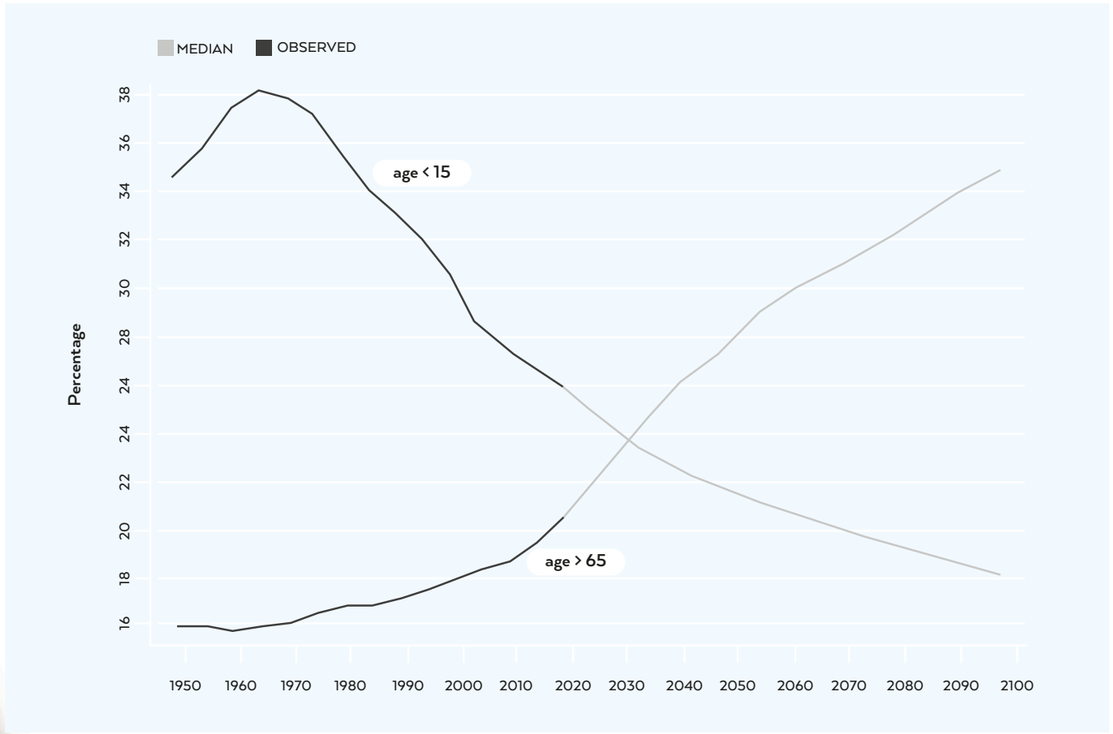
Apart from the traditional eating occasions, consuming protein during the recovery period after training or a match is a priority, because heavy exercise stimulates muscle protein synthesis and recovery.[35] Also consuming a portion of protein just before going to sleep may stimulate muscle protein synthesis during the night and so helps to optimize the opportunity for recovery overnight.[18] Typically muscle protein synthesis decreases during the night while the regular muscle protein breakdown continues. This results in a negative protein balance in the body in the morning. When athletes consume a portion of protein just before going to sleep, they may benefit from a positive protein balance during the night.[18]

AGEING AND NUTRITIONAL CHALLENGES

People are getting older and life expectancy has increased significantly over the last century.[36] However, the extra years are not always spent in good health. Globally, healthy life expectancy is around 8 years lower compared to life expectancy at birth.[36]

Nutrition and exercise are two key factors to improve quality of life and stimulate healthy and active ageing. Adequate nutrition - including enough protein and energy - helps in maintaining bodily functions and prevents muscle wasting and the loss of muscle strength with ageing.[36,37] When health is compromised, this becomes even more important. In particular, the need for protein increases in frail sarcopenic elderly and malnourished patients suffering from acute or chronic illnesses.[38,2] These higher protein requirements are sometimes hard to meet. Ageing affects the dietary choices of older adults and in general, nutritional intake can decline with age.[36,37,39] Loss of appetite and a decrease in ability to taste and smell can result in lower intakes of protein, energy and certain micronutrients.[36,39] Also conditions such as dysphagia, slower gastric emptying, altered hormonal responses and the presence of diseases can compromise food intake, and thereby protein intake.[40] In these situations, ready to drink protein rich formulas and medical nutrition supplements can help achieve recommended protein levels.

CHILDREN AND OLDER PEOPLE AS A PERCENTAGE OF GLOBAL POPULATION: 1950 - 2100



Adapted from: United Nations, DESA, Population Division. World Population Prospects 2019. https://population.un.org/wpp/

The role of PROTEIN IN AGEING

Decrease of muscle mass

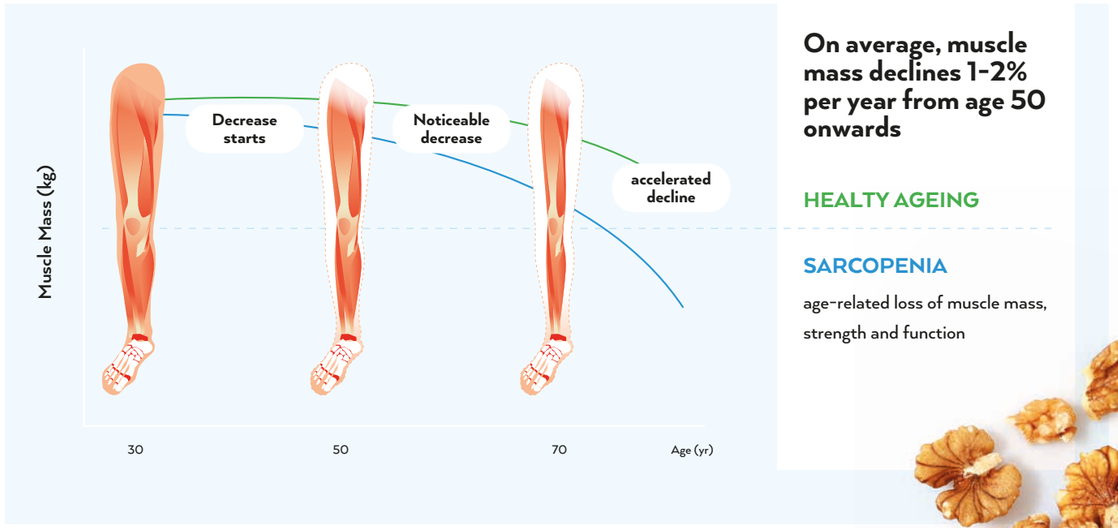
Both muscle mass and muscle strength decrease with age. Muscle loss starts from age 30: very slowly at first and almost unnoticeable. From the age of 50, the loss of muscle mass becomes noticeable. The loss further accelerates after the age of 70. On average, muscle mass declines 1-2% per year from age 50 onwards.[41-42]

Why does muscle mass decrease?

In adults, muscle mass is reasonably stable with muscle tissue being constantly built and broken down. However, with ageing and also disease, the balance between the build-up and breakdown of muscle tissue becomes negative, causing muscle mass to decrease.[43]

Possible causes of a decrease in muscle mass with ageing or disease include:[2,10,43]

- Insufficient protein intake
- Reduced physical activity
- Reduced utilization of protein (anabolic resistance)
- Increased protein requirement due to inflammation and catabolic conditions associated with chronic and acute diseases



On average, muscle mass declines 1-2% per year from age 50 onwards

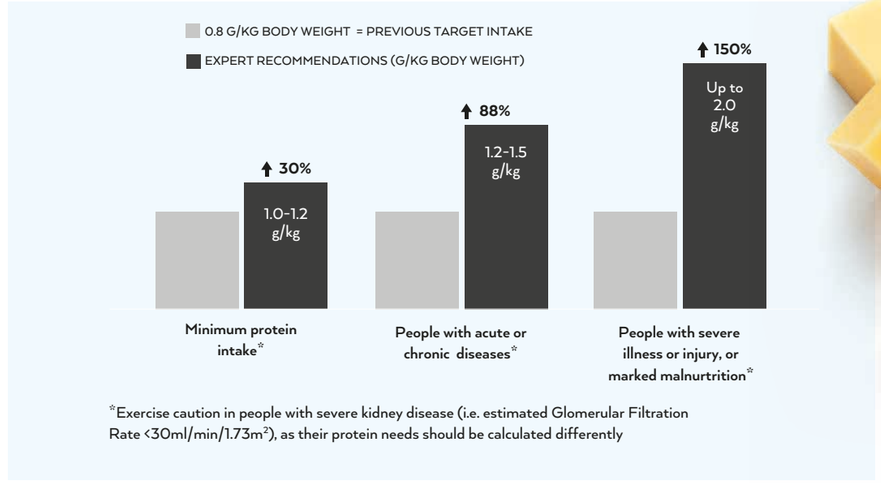
HEALTY AGEING

SARCOPENIA

age-related loss of muscle mass, strength and function

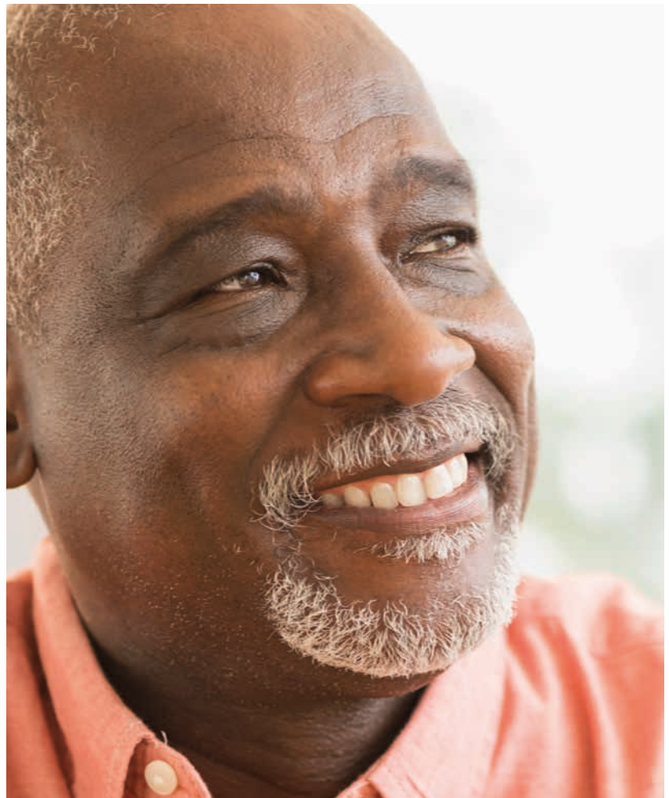
PROTEIN RECOMMENDATIONS

NEW RECOMMENDATIONS CALL FOR HIGHER PROTEIN INTAKE (G PER KG OF BODY WEIGHT) IN THOSE AGED > 65 YEARS



*Exercise caution in people with severe kidney disease (i.e. estimated Glomerular Filtration Rate <30ml/min/1.73m²), as their protein needs should be calculated differently

Good nutrition, especially adequate protein intake, can help to limit the age-related decline in muscle mass, strength and functional abilities.[38] Most health authorities recommend a protein intake of 0.8 gram per kg body weight/day for adults of all ages. However, there is increasing evidence that a higher protein intake is beneficial for older adults to maintain muscle mass. International expert groups have recently presented protein recommendations for older adults (> 65 years) to maintain healthy muscles: [2,38]



- Healthy older adults are advised to consume 1.0 to 1.2 gram of protein per kg body weight/day.*
- For malnourished elderly or elderly at risk of malnourishment due to acute or chronic illness, a higher protein intake is recommended: 1.2 to 1.5 gram of protein per kg body weight/day.*
- Patients with severe illness or injury or with marked malnutrition may need as much as 2.0 g/kg body weight/day.*
- The recommended amount of protein for older adults per meal or after training is 25 to 30 grams of high-quality protein, with 2.5 to 2.8 grams of leucine.

*Exercise caution in people with severe kidney disease (i.e. estimated Glomerular Filtration Rate <30ml/min/1.73m²) as their protein needs should be calculated differently.

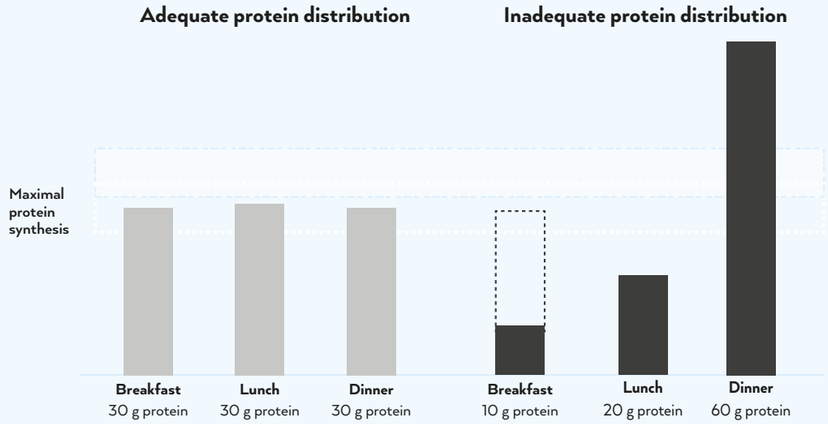
PROTEIN AND EXERCISE

Guidelines older adults

Adequate protein intake in combination with exercise is considered optimal for maintaining muscle mass in older adults.[38]

High-quality proteins seem to be the best choice for older adults to stimulate muscle protein synthesis.[10] Exercise, particularly resistance exercise, enhances the response of muscle protein synthesis to amino acids derived from dietary protein. Resistance exercise stimulates muscle protein synthesis for at least 48 hours after exercise, but the magnitude of the post-exercise response of muscle protein synthesis diminishes over time.[44,45]

Both resistance training and aerobic exercise are beneficial for older adults. The amounts of physical activity and exercise that are safe and well tolerated depend on each individual's health.[2] General guidelines advise 30 minutes of endurance exercise per day and resistance exercise for 10 to 15 minutes or more per session two to three times per week.[2]



Adapted from Paddon-Jones et al. 2009

PROTEIN DISTRIBUTION

There are indications that not only the total amount of protein and protein quality are important for muscle protein synthesis for older adults, but also the distribution of protein intake over the day. It is advised to divide protein intake evenly over the three main meals: breakfast, lunch and dinner.[46] Other beneficial opportunities for protein intake are before going to sleep and after exercising.[47]

In general, breakfast is small compared to lunch and/or dinner, and often contains a relatively low level of protein. Since breakfast is the meal following a long period of fasting (overnight), it is beneficial to include a significant amount of protein at this time of day. Research shows that 25 to 30 gram of protein intake at each meal is required to maximize muscle protein synthesis in older adults.[2]

FRAILTY

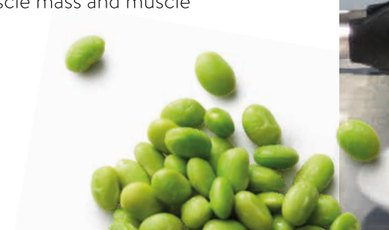
Frailty is a multidimensional syndrome that consist of a cumulative decline in multiple body systems and functions. Although definitions of frailty vary, frailty is generally characterized by decreased reserves, resulting in extreme vulnerability to stressors. Relatively small events, such as a minor infection, can have large effects on health status, leading to increased dependency and other adverse health outcomes.[37,42,48]

Frailty can either be a physical or psychological condition, or a combination of both. It is estimated that physical frailty is present in approximately 10% of persons older than 65 years, with the prevalence increasing in persons older than 80 years. Women seem to be twice as likely as men to become frail.[49]

SARCOPENIA

Nutrition plays an important role in the development of frailty and it's key component sarcopenia.[37] Sarcopenia is the loss of muscle mass, strength and physical function below a critical threshold.[42] The European Working Group on Sarcopenia in Older People defined sarcopenia as probable when a person has low muscle strength. The additional presence of low muscle mass or low muscle quality confirms the diagnosis. If low physical performance is observed as well as low muscle strength and low muscle quantity/ quality, sarcopenia is considered severe.[42]

Sarcopenia increases the risk of falls and bone fractures, impairs the ability to perform activities of daily living such as getting out of bed and carrying groceries and food preparation, and contributes to lowered quality of life, loss of independence or need for long-term care placement.[42] Therefore, it is important to prevent or limit the loss of muscle mass and muscle strength with ageing.



SARCOPENIA IN frail ELDERLY

NUTRITION

Prevention of loss of muscle and strength can be achieved by a varied diet, adequate protein (1.0 to 1.5 g/kg body weight/day) and energy intake and regular exercise. [2,40,38,49] Also, reduction of polypharmacy and vitamin D supplementation in those who are deficient can help in the prevention and treatment of frailty.[49] To ensure adequate intake of protein, energy and micronutrients and prevent weight loss, intake of high-quality, nutrient dense foods is essential for frail elderly.[37]

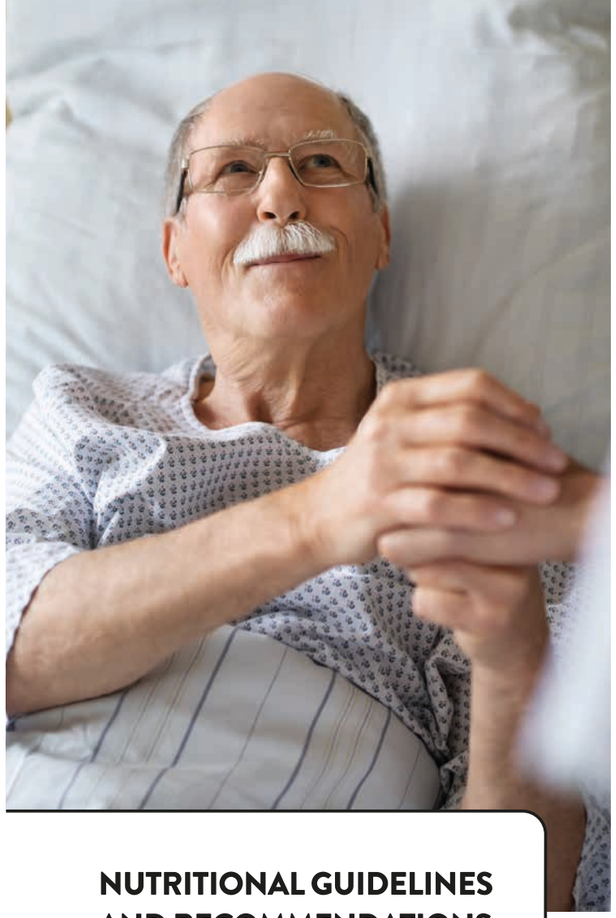
However, meeting dietary requirements and sufficient energy intake can be difficult. Around 10% of community-dwelling older adults and one-third of those living in care homes do not meet a protein intake of 0.7 g/kg body weight/ day.[40] Studies have also shown that frailty is associated with a decrease in energy intake.[40] Independently of body mass index, daily energy intake was found to be lowest in people who were frail, followed by pre-frail, and highest in people who were not frail.[40] Reduced energy intake can occur due to a reduction in appetite referred to as the anorexia of aging.[40] This can be caused by an altered taste and smell sensation, slower gastric emptying and altered hormonal responses. Also physical and mental impairments, chewing and swallowing problems, the presence of diseases and polypharmacy can play a role.[40] When food intake is reduced, the intake of high-quality proteins stimulates muscle protein synthesis most effectively, and can thus help to maintain muscle mass.[10]

PATIENTS

In hospitals and care homes, high levels of malnutrition are prevalent. Worldwide, one-in-four adult patients in hospitals, and more than one-in-three care home residents are malnourished or are at risk.[51] This disease-related malnutrition is caused by insufficient dietary intake as a result of the disease and its treatment.

The impact of disease-related malnutrition is extensive and can have severe consequences:[51]

- Impaired immune response and wound healing leading to significantly higher complication and infection rates.
- Longer hospital stays, more hospital visits and readmission.
- Poorer quality of life of patients and frail people at all stages of life.
- Increased risk of mortality.



NUTRITIONAL GUIDELINES AND RECOMMENDATIONS

Maintaining sufficient levels of energy, through carbohydrates, fats and proteins is crucial for disease management. This can be achieved through whole foods. When this is insufficient medical nutrition and/or supplements can be considered. The European Society for Clinical Nutrition and Metabolism (ESPEN) recommends an energy intake of 30 kcal per kg of body weight per day to older persons, apart from in the cases of those who are underweight.[59]

However, recommendations for protein intake rise with age. Malnourished elderly or elderly at risk of malnourishment due to acute or chronic illness are advised a protein intake of 1.2 to 1.5 gram of protein per kg body weight/day. Patients with severe illness or injury or with marked malnutrition may need as much as 2.0 g/kg body weight/day.[38]

DIAGNOSIS AND TREATMENT

For a person to be defined as malnourished, at least one phenotypic and one etiologic criterion must be diagnosed. Phenotypic criteria include weight loss, reduced body mass index and reduced muscle mass, while etiologic criteria are reduced food intake and disease burden.[52]

There is substantial evidence to suggest that protein is highly valuable in addressing phenotypic criteria, thanks to its crucial role in muscle health and function.[53,54] Research shows healthy muscles support three key areas of health that are essential for recovery after illness or surgery:

1. Healthy muscles can increase metabolic function, which helps the body to utilize valuable protein.[53,54]

2. Maintaining muscle mass improves the body's resilience by supporting immunity, wound healing and recovery. This can help accelerate recovery and reduce the likelihood of further complications for patients, or the resurgence of disease.[55-56]

3. Healthy muscles support physical function, by helping to improve mobility and enabling patients to re-start daily activities.[2,38,57-58]

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Version: December 2020